

NUCLEONICA: A PLATFORM FOR ORGANISATIONAL KNOWLEDGE MANAGEMENT IN THE NUCLEAR DOMAIN

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ABSTRACT

The nuclear science web portal Nucleonica is considered from a knowledge management perspective. In particular, Nucleonica's "knowledge objects" are considered within the context of Nonaka's "knowledge spiral" model for organisational knowledge creation, transfer and dissemination.

1. Introduction

As a result of recent developments on issues such as energy security, nuclear security and protection of the environment, we are witnessing a resurgence of interest in nuclear power. In order to support this development we will need a nuclear skills renaissance through education and training. To address such issues, the Nucleonica nuclear science web portal [1] has been developed for education, training and knowledge management in the nuclear sciences. In this paper, the web portal is considered from a knowledge management perspective. Of crucial importance in this context is the "know-how" transfer within organisations. One of the key issues here is how to extract the tacit knowledge from employees before they retire or leave an organisation and pass this on to a new generation of employees. Nonaka and Takeuchi [2] have proposed a model for organisational knowledge creation and transfer which is probably the most widely cited theory in knowledge management today. The authors argue that knowledge is created through a continuous and dynamic interaction between tacit and explicit knowledge. They conceptualised this model as a "knowledge spiral" (shown in Fig. 1) in which there are four modes of knowledge conversion: socialization, externalization, combination and internalization (SECI model).

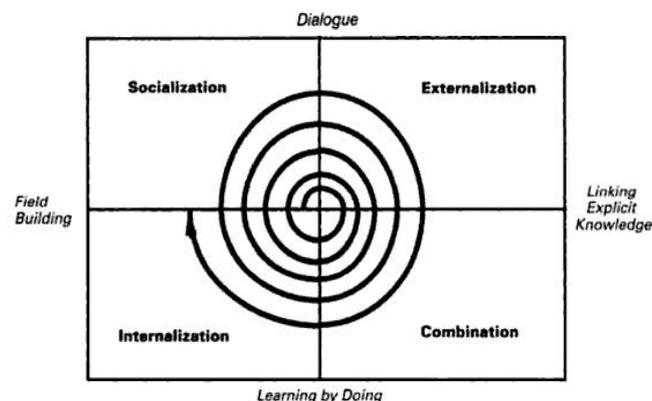


Fig.1 The spiral of organizational knowledge transfer and dissemination by Nonaka [1]

Socialisation is the conversion of tacit knowledge to tacit knowledge. The example given is that of an apprentice who works with his tutor and learns from observing and imitating the tutor's actions. *Externalization* is the conversion of tacit to explicit knowledge (discussed in

more detail below). *Combination* is the conversion of explicit to explicit knowledge. This is the process of systemizing already explicit knowledge into a knowledge system. A common facilitator for this conversion from explicit to explicit knowledge is a computerized knowledge database in organisations. Internalization is the conversion from explicit to tacit, which is closely related to "learning by doing". This is the process by which, tacit knowledge that has been made explicit through externalization is integrated in the tacit knowledge base of other members of the organization. Thus, at the end of the spiral process, when knowledge has been socialized, combined, externalized and internalized, one or more individuals in the organisation have acquired new tacit knowledge.

2. Nucleonica's Knowledge Objects and the Knowledge Spiral

Nucleonica is based on a number of "knowledge objects" [3] ranging from the actual scientific applications to the forum and the wiki. In contrast to conventional paper-based documents, these are "electronic" knowledge objects (EKO). The aim here is to produce high quality information resources which are easily accessible to any user. In the context of Nonaka's knowledge spiral and the SECI model, these EKO are aimed at supporting and enhancing the knowledge creation, transfer, and dissemination processes. In this section, these EKO are described in more detail.

2.1 Nucleonica Application Development (Socialisation)

The first step in the development of a Nucleonica application involves the Nucleonica team working together with an expert to develop an application module. This step can be directly compared with the "socialization" step in the SECI knowledge spiral model in which the "tutor" is the expert and the "apprentices" are the Nucleonica developers. The main issue here is developing a close relationship with the expert or "tutor" to try to crystallise his knowledge and know-how and to concentrate on the essential features of the program. A further goal in this first step is the creation of a "knowledge object" i.e. a full working version of the web-based scientific application.

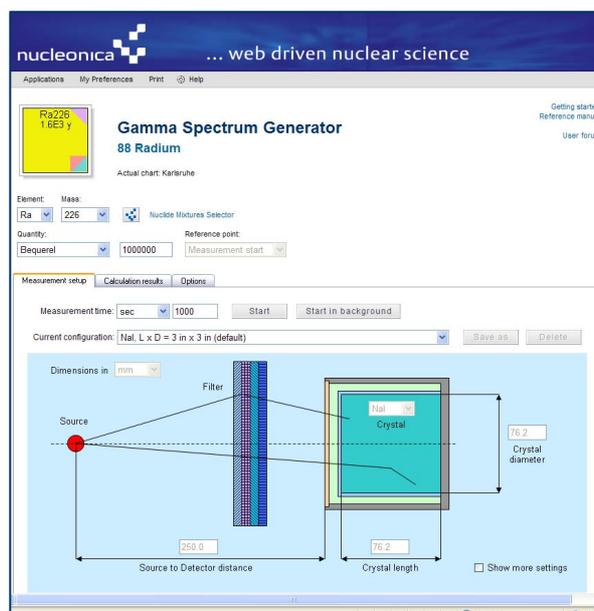


Fig. 2 The first step in the creation of a new Nucleonica application is the creation of a user friendly, intuitive user interface (shown for the Gamma Spectrum Generator [4]).

The web-based applications in Nucleonica fall into two categories. In the first category, the web-based application is created "from scratch". The Nucleonica developers work together with an expert in a particular area to develop a new application. In the second category, an application has been developed by an expert and exists as a standalone program with its

own graphical user interface (GUI). Many man-years of effort have gone into the development of such programs and it is not feasible to rewrite the application. In such cases, the program's own GUI is deactivated and a dll or exe is used for data input and output. The technical issue of converting a stand-alone application to web-based is that the interactions between the user and the application have to be organised inside an internet browser.

2.2 Nucleonica Forum (Externalisation)

The Forum in Nucleonica is the main tool used for the "Externalisation" process within the SECI model. Online forums today are public meeting places for open discussion on the internet. It is clear that the collective intelligence resulting from the collaboration of thousands or even millions of people from different backgrounds can be a powerful and reciprocal knowledge source. This attribute of mass-collaboration is one of the main strengths of online forums. The scale of these online forums is given by Big-Boards.com – a website which provides a ranking of the largest forums worldwide. The minimum requirement for being ranked on the big-boards.com website is to have a forum with a minimum of 500,000 posts. Currently, the site ranks over 2300 message boards in its database, constituting internet forums with well over a billion posts. Considering that the top 10 forums have each an average of approximately 337 million posts, the massive volume and potential of online forums becomes clear. Although not on the same scale, science forums such as PhysicsForums.com with around 2.5 million posts are clearly potentially valuable knowledge sources.

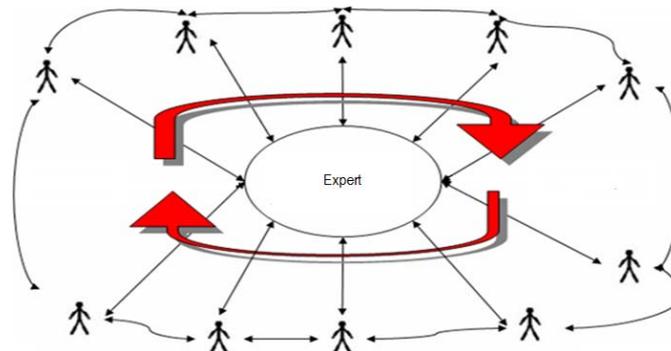


Fig. 3 An intensive dialogue between the expert(s) and the users is a necessary pre-requisite for the conversion of tacit to explicit knowledge [5].

The main goal of the Nucleonica forum is to capture the tacit knowledge of experts and peers alike within the specific context of the Nucleonica applications. Initially the user will have little knowledge of the application. However, after some experimentation, the user can post questions in the Nucleonica forum dedicated to this particular application. The approach is based on a question and answer interaction between the expert (and the Nucleonica developers) who possesses tacit knowledge and users. The knowledge or know-how flow is "externalized" by the fact that the question and answer dialogue is fully recorded in the forum database. Initially, the interaction primarily takes place in a dialogue between the expert(s) and the users. Once a certain amount of interaction has taken place, the users start interacting with each other until the point where the tacit knowledge of the expert has been made explicit in the forum database. At this point, the tacit knowledge has been transformed into explicit knowledge. This "externalization" process is illustrated in fig. 3.

2.3 Nucleonica Wiki (Combination)

Within the SECI model, the "Combination" process makes extensive use of a wiki systemizing explicit knowledge. The Nucleonica wiki [6] is based on the MediaWiki - the same "engine" used by the online encyclopedia Wikipedia. The primary use of this wiki is to provide all the technical documentation or articles required to support the various Nucleonica

applications. The basic characteristic of a wiki is that it allows the article author to directly edit and add content online (the word "wiki" means fast in Hawaiian) - there is no need for a web master or programmer to convert the text into html. In addition to providing an online Help for the applications, the Nucleonica wiki is also used to provide additional EKO's such as a Glossary of Nuclear Science, Ask an Expert and Frequently Asked questions (FAQs). These features allow Nucleonica to grow organically and provide a powerful nuclear science information source for its users.

2.4 Nucleonica Applications (Internalization)

The final step in the SECI knowledge spiral is the internalization. Internalization is the conversion from explicit to tacit, which is triggered through "Learning by Doing". This is the process by which tacit knowledge, that has been made explicit through externalization and combination, is then integrated back into the tacit knowledge base of other members of the organisation. The Learning by Doing concept has been developed by Arrow [7] and refers to the ability of workers to improve their skills by regularly repeating the same types of action. The Nucleonica applications are a direct manifestation of this concept. No expert knowledge is required to use the applications. At the simplest level, the user can "play" with the user friendly scientific applications with one or two mouse clicks. Technical Help is given in the wiki. As the user becomes more confident and gains increasing experience, he can attempt more sophisticated calculations. Through this iterative process and constant reference to the explicit information in the wiki, more and more expertise is gained. As a consequence the tacit knowledge that has been made explicit through the externalization and the explicit knowledge contained in the wiki are converted into tacit knowledge of the users through the "learning by doing" process. It is in this final step that concludes the knowledge spiral and the tacit knowledge that has been made explicit is integrated back into the tacit knowledge base of other members of the organization.

2.5 Nucleonica – A Virtual Community of Practice

Nonaka and Takeuchi [2] argue that the externalization process, i.e. a conversion from tacit to explicit knowledge, requires a dynamic and interactive environment that facilitates knowledge conversion. Environments that exhibit these characteristics are usually called "communities of practice" – a term coined by Lave and Wenger [8]. A Community of practice is defined as... "Groups of people informally bound together by shared expertise and passion for a joint enterprise" (Wenger and Snyder [9])

Wenger and Snyder [9] argue that Communities of Practice differ from organizational teams in the aspect that they are driven by the passion, commitment and identification of individuals with regards to a certain subject area rather than by job requirements or project milestones. The Nucleonica platform, through features such as the online forum and social networking groups, clearly provides such a dynamic and interactive environment. It also suits the definition, since the platform informally bounds people together by a shared expertise and passion for nuclear science. Hence, Nucleonica is a virtual community of practice that provides an environment in which the externalization process of knowledge conversion can take place. In particular, the Nucleonica online forum is an optimal facilitator of the knowledge conversion process and Desanctis et al. [10] already identified online forums as an example of a community of practice.

3. Nucleonica – A Virtual Knowledge Marketplace

In the previous sections we have considered how Nucleonica can be used as a platform for nuclear knowledge management within an organisation. There is considerable potential, however, to "reach" beyond a single organisation to the nuclear domain in general. Indeed Nucleonica currently has users from over 80 countries worldwide. There are three main areas where Nucleonica can be further exploited. First, to provide an environment where nuclear scientists exchange and increase their knowledge with each other and thereby contribute to a large public knowledge base for nuclear science. Secondly, the scientists can

assist each other on a reciprocal basis on research projects and lead to the Nucleonica platform becoming a "social networking research department" for researchers' problems. Finally, the exchanged collective intelligence can be used by organizations to solve research problems in a more efficient manner through employing "crowdsourcing". Crowdsourcing refers to the phenomenon whereby an organisation outsources a problem rather than solving it internally. There are already a variety of platforms that have adopted this form of problem solving such as "Innocentive" [11] – where all kinds of organizational research problems are solved by individuals. Clearly, using the collective brainpower of experts is more cost-effective than employing scientists to solve problems themselves. Considering the collective brainpower in the field of nuclear science, it is clear that Nucleonica has the potential to become the "knowledge marketplace" in this field.

4. Conclusions

It has been shown that the Nucleonica nuclear science portal can be used as a platform for organisational knowledge management in the nuclear domain. Nucleonica's "knowledge objects" are fully consistent with Nonaka's knowledge management theory and can be used for a technical implementation of the SECI model for knowledge socialisation, externalisation, combination and internalisation. The platform can be used in the public domain as well as internally by organizations as a standalone application. Nucleonica has the potential of becoming a "knowledge marketplace" in the field with its focus on education and training, collaborative research as well as for providing commercial solutions to organizations.

5. References

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